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was genial and companionable. He had reached middle life before he was freed from the load which poverty imposes on one who has a family to support, but, struggling along as best he could, he made himself a leader among scientific men. His gentle manner and delicacy of feeling, joined with a cheerful, even sprightly disposition, made him beloved by his associates and the friend even of those who differed with him in opinion. Few have been permitted to enjoy so many years of unremitting mental activity. Lesquereux was over eighty before the warning came that his work must be relaxed. Two years before his death he suffered a stroke of paralysis, and he grew gradually more and more feeble, until he died at his home in Columbus, October 25, 1889, nearly eighty-three years old.

#### ELIAS LOOMIS.

ELIAS LOOMIS was born in Willington, Connecticut, on August 7, 1811. His father, the Rev. Hubbell Loomis, was pastor in that country parish from 1804 to 1828. He was a man possessed of considerable scholarship, of positive convictions, and of a willingness to follow at all hazards wherever truth and duty, as he conceived them, might lead.

Although the boy inherited from his father a mathematical taste, yet his love for the languages also was shown at a very early age. At an age when many bright boys are still struggling with the reading of English, he is reported to have been reading with ease the New Testament in the original Greek. He prepared for college almost entirely under the instruction of his father. At the age of fourteen he was examined and was admitted to Yale College, but owing to feeble health he waited another year before actually entering a class. In college he appears to have been about equally proficient in all of the studies, taking a good rank as a scholar, and maintaining that rank through his college course. He graduated in 1830.

The next year was spent in teaching. In 1831 he entered the Andover Theological Seminary with the expectation of becoming a preacher. This purpose was, however, changed, when a year later he was appointed Tutor in Yale College. Here he remained for three years and one term. In the spring of 1836 he received the appointment to the Chair of Mathematics and Natural Philosophy in Western Reserve College, at Hudson, Ohio. He was allowed to spend the first year in Europe. He was, therefore, during the larger part of the year 1836-37, in Paris, attending the lectures of Biot, Poisson, Arago,

Dulong, Pouillet, and others. In the autumn of 1837 he began his labors at Hudson. Here he remained for seven years, maintaining with unflagging perseverance both his work in teaching and his scientific labors.

In 1844 he was offered, and he accepted, the office of Professor of Mathematics and Natural Philosophy in the University of New York.

When Professor Henry resigned his professorship at Princeton in order to accept the office of Secretary of the Smithsonian Institution, Professor Loomis was offered the vacant chair. He went to Princeton and remained there one year, at the end of which he was induced to return again to New York. Here he continued until 1860, when he was elected to the professorship in Yale College made vacant by the death of Professor Olmsted. For the last twenty-nine years of his life he there labored for the College and for science, passing away on the 15th of August, 1889.

There are three or four lines of the scientific activity of our late Associate sufficiently distinct to be considered separately, without strict regard to chronology.

*Terrestrial Magnetism and the Aurora.* — A subject of which he early undertook the investigation was Terrestrial Magnetism. The daily motions of the magnetic needle were those which Tutor Loomis first studied. At the beginning of the second year of his tutorship, he set up by the north window of his college room a heavy wooden block, and on it the variation compass belonging to the College. Here for thirteen months he observed the position of the needle at hourly intervals in the daytime, his observations usually being for seventeen successive hours of each day. The results of these observations, together with a special discussion of the extraordinary cases of disturbance, were published in the *American Journal of Science* in 1836. No similar observations of the kind made in this country had at that time been published, and it is believed that there are only one or two like series of hourly observations made in Europe earlier than these by Tutor Loomis. He also at this time formed the purpose of collecting all the observations of magnetic declination that had hitherto been made in the United States. From these he constructed a magnetic chart of the country. These were the first published magnetic charts of the United States. In the following years he made numerous observations of the magnetic dip at widely distributed stations in the United States, — observations which are of great value in present discussions of the changes of the magnetic elements.

Closely connected with terrestrial magnetism, and to be considered

with it, is the *Aurora Borealis*. Observations and discussions of an exceedingly brilliant display of Northern Lights, which occurred in 1859, were given to the public by Professor Loomis during the following two years, in a series of nine papers in the *American Journal of Science*. In 1870 he published a paper of importance relating to terrestrial magnetism, in which he showed its connection and that of the aurora with spots on the sun. A further discussion of the periodicity of the auroras was undertaken by Professor Loomis, and published in 1873.

*Astronomy.* — Another important line of Professor Loomis's work was Practical Astronomy. While in Europe in 1836–37 he bought for Western Reserve College the instruments for an observatory. These were a four-inch equatorial, a transit instrument, and an astronomical clock. On his return he erected, in 1837, a small observatory at Hudson, and in September, 1838, began to use the instruments. It may not seem a very large output of work in six years' time to have determined the location of the observatory, and to have observed five comets. But we must remember that the telegraph had not then been invented, that the exact determination of the longitude of a single point in the Western country had a higher value then than it can have now, and that it could be obtained only by slow and tedious methods. These were moreover, days of small things in astronomy in this country. At Yale College there was a telescope, but not an observatory. At Williamstown an observatory had been constructed, but it was used for instruction, not for original work. At Washington Lieutenant Gilliss, and at Dorchester Mr. Bond, were commissioned by the government in 1838 to observe moon culminations, in correspondence with the observers in the Wilkes Exploring Expedition, for determining their longitude. These two prospective sets of observations, both of them under government auspices and pay, were the only signs of systematic astronomical activity in the United States outside of Hudson, when in 1838 Professor Loomis began his observing there.

In the summer of 1844, a new method in astronomy had its beginnings. The telegraph line had just been built between Baltimore and Washington, and Captain Wilkes at Baltimore compared his chronometer by telegraph with one at Washington, and so determined the difference of longitude of the two places. This method was immediately utilized by Professor Bache in the Coast Survey, and for three seasons Professor Loomis aided Mr. Walker in developing the new method, and making it practically useful.

*Meteorology.* — The science of Meteorology is, however, that in which Professor Loomis has made the most important contributions to human knowledge. From the date of his tutorship at Yale, Professor Loomis had taken a warm interest in meteorology; and in particular its central problem, the theory of storms, held in his thought and work the first place from that time to the day of his death. For several years, in Hudson, he steadily performed the naturally irksome task of making twice each day a complete set of meteorological observations. He also undertook the discussion of several large storms. A paper giving the results of the discussion of two of these storms, occurring in the month of February, 1842, was sent to Professor Bache, and read by him at the centennial meeting of the American Philosophical Society in May, 1843, and created, as Professor Bache wrote, a great sensation. It was at that time important for the light which it threw upon the rival contending theories of Espy and of Redfield, but it was more important by far by reason of the new method of investigation then for the first time employed. In this discussion of the storms of 1842, Professor Loomis drew on the map a series of lines of equal barometric pressure, or rather of equal deviation from the normal average pressure for each place. A series of maps representing the storm at successive intervals of twelve hours were thus constructed, upon each of which was drawn a line through all the places where the barometer stood at its normal or average height. A second line was drawn through all the places where the barometer stood  $\frac{1}{10}$  of an inch below the normal; and other lines through points where the barometer was  $\frac{4}{10}$  below,  $\frac{6}{10}$  below,  $\frac{8}{10}$  below, etc.; also lines were drawn through those points where the barometer stood  $\frac{2}{10}$ ,  $\frac{4}{10}$ ,  $\frac{6}{10}$ , etc., above its normal height. The deviations of the barometric pressure from the normal were thus made prominent, and all other phenomena of the storm were regarded as related to those barometric lines. A series of colors represented respectively the places where the sky was clear, where the sky was overcast, and where rain or snow was falling. A series of lines represented the places at which the temperature was at the normal, or was 10, 20, or 30 degrees above the normal or below the normal. Arrows of proper direction and length represented the direction and the intensity of the wind at the different stations. These successive maps for three or four days of the storm furnished to the eye all its phenomena in a simple and most effective manner. The method seems so natural, that it should occur to any person who has the subject of a storm under consideration. But the greatest inventions are oftentimes the simplest, and the

invention and introduction of this method of representing and discussing the phenomena of a storm was probably the greatest of the services which Professor Loomis rendered to science. This method is at the foundation of what is sometimes called "the new meteorology," and the paper which contains its first presentation is perhaps the most important paper in the history of that science.

At the close of this memoir Professor Loomis warmly urged the plan of a systematic meteorological campaign. Shortly afterwards this Academy appointed a committee, of which Professor Loomis was chairman, to urge upon the proper authorities the execution of the plan. The American Philosophical Society of Philadelphia united its voice with that of the Academy. About this time Professor Henry was made Secretary of the Smithsonian Institution, and he determined to make American meteorology one of the leading subjects of investigation to be aided by the Institution. At Professor Henry's request, Professor Loomis prepared a report upon the meteorology of the United States, in which he showed what advantages society might expect from the study of the phenomena of storms; what had been done in this country toward making the necessary observations, and toward deducing from them general laws; and, finally, what encouragement there was to a further prosecution of the same researches. He then presented in detail a practicable plan for securing the hoped for advantages in their fullest extent.

The scheme laid down by Professor Loomis was in part followed out by the Institution. But the fragmentary character of the observations, the want of systematic distribution of the observers, and the imperfections of the barometers, made the material collected difficult of discussion. Professor Loomis waited in hopes of some better system.

This better system came when the United States Signal Service was established, in 1871. The daily maps of the weather published by the Bureau were constructed essentially after the plan which Professor Loomis had, thirty years before, invented for the treatment of the storms of 1842. As soon as these maps had been published for the two years 1872 and 1873, Professor Loomis commenced in earnest to deduce from them the lessons which they taught us respecting the nature and the phenomena of United States storms. To this investigation he gave nearly all his energies during the remaining fifteen years of his life. Beginning in April, 1874, he presented at each of eighteen successive meetings of the National Academy of Sciences, in April and in October of each year, a paper entitled "Contributions to Me-

teorology." These were at first based upon the publications of the Signal Service alone; but, as years went by, like publications appeared in Europe that were useful for his work. These papers were published in July and January following the Academy meeting, and they regularly formed the first and leading article in eighteen successive volumes of the "American Journal of Science." Gradually, one after another of his college duties was committed to others, that he might give his whole strength to these investigations. In 1884 he began a revision of the whole series of papers. They had been presented without much regard to systematic order in the subjects investigated, and new material had accumulated from time to time, so that a thorough systematic revision seemed absolutely necessary.

In 1885 he presented to the National Academy of Sciences the first chapter of this revision, in which he discussed the areas of low pressure, their form, their size, their motions, and the phenomena attending them. Two years later, in 1887, the second chapter of the revision appeared, in which he discussed the areas of high pressure, their form, magnitude, direction, and velocity of movement, and their relation to areas of low pressure. Gradually his physical strength was failing, though his mind was bright and clear as ever. To this work—the only work which he was now doing—he was able to give two or three hours a day. Anxiously he husbanded his strength, slowly and painfully preparing the diagrams and the tables for the third chapter upon rain areas, the phenomena of rainfall in its connection with areas of low pressure, and the varied phenomena of unusual rainfall. "I see," he said to a friend, "not the end of this subject, but where I must stop. I hope I shall have strength to finish this work, and then I shall be ready to die."

This third and finishing chapter was finally passed through the printer's hands, and some advance copies distributed to correspondents abroad, in the summer months of 1889. His work upon the theory of storms he felt was finished. Before the close of the vacation he died.

These three chapters of his revised edition of "Contributions to Meteorology" constitute the full and ripe fruitage of his work in his favorite science. They will for a long time to come be the basis of facts by which writers in theoretical meteorology must test their formulas. They cover all the important points taken up in the twenty-three earlier memoirs, with one important exception, the relation of mountain observations to those made on the plains below.

Professor Loomis became interested in the subject of genealogy early in life, and that interest remained unbroken to his last days.

He published three large volumes, giving the names, residences, etc. of about twenty-seven thousand descendants of his ancestor, Joseph Loomis, who came from England to this country in 1638.

Professor Loomis was doubtless more widely known as the author of mathematical text-books than as a worker in new fields of science. Shortly after coming to New York, he prepared a text-book in Algebra. The market was ready for a good book of this kind, and the work prepared for it was a good one. Other books followed the Algebra from year to year, the whole forming a connected series from Arithmetic upward, so that the list of his works finally numbered near twenty volumes. His experience in teaching, his rare skill in language, his clear conception of what was important, and his unwearied painstaking, combined to produce text-books which met the wants of teachers. About six hundred thousand volumes have been sold, benefiting the schools and colleges, and bringing to the author a liberal and well merited pecuniary return.

College graduates who have been under his instruction will probably retain a more positive impression of the personal traits and the character of Professor Loomis than of most of their other teachers. His crisp sentences, lucid thought, exactness of language, and steadiness of requirement, more than made up for any apparent coldness and real reserve. "If I have been successful in life," said Chief Justice Waite (a member of the Yale College class of 1837), "I owe that success to the influence of Tutor Loomis more than to any other cause whatever." Professor Loomis lived a somewhat isolated life, especially in his later years, but there was in him no trace of selfish or morbid feeling. In council his advice was always marked by his clear judgment of what was important, and at the same time what was practicable.

After going to New York he had a generous income from his books, besides his salary as Professor. The amount he saved from his income was carefully and prudently invested, and before his death the savings with their accumulations were a large estate, — how large only he and his banker knew. After making liberal provision for his two sons, he bequeathed his estate to the Astronomical Observatory of Yale University. The income from more than three hundred thousand dollars will eventually be available to continue the work of his life.